National Aeronautics and Space Administration

Langley Research Center's

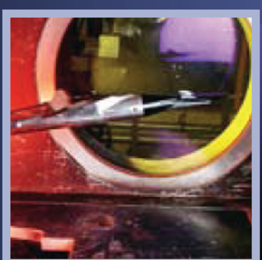
Aerothermodynamics Laboratory

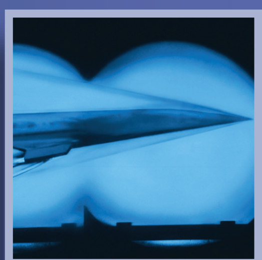
An amalgamation of four hypersonic wind tunnels, NASA's Aerothermodynamics Laboratory (AL) was designed and constructed in the late 1950s and early 1960s. The AL has contributed to all of the nation's major hypersonic vehicle programs.

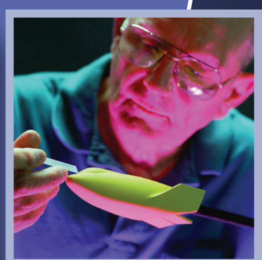
Today the Laboratory is used to assess the aerodynamic performance and aeroheating characteristics of advanced aerospace-vehicle concepts. The Laboratory is also utilized to conduct fundamental-flow physics research and Computational Fluid Dynamics (CFD) code calibration and verification.

The AL provides Mach 6 to 18 simulation at a wide range of unit Reynolds numbers and normal shock-density-ratio parameters. In addition to experimental aerothermodynamics, the AL provides a full range of computational aerothermodynamics from subsonic to hypersonic regimes.

Surface heat-transfer rates are measured using thin-film resistance gauges, infrared imaging systems, thermocouples, and global two-color thermographic phosphors.







Facility Benefits

- The laboratory includes four calibrated, high-fidelity hypersonic wind tunnels and a CFD grid-generation laboratory
- Close-coupled synergy between facilities provides a wide range of hypersonic simulation parameters and unique characteristics
- Near real-time data reduction is available
- Standardized data acquisition systems and instrumentation at all AL facilities enable shared-resource utilization and common model-hardware designs
- There is a large stable of six-component, force-and-moment balances for aerodynamic testing
- Aeroheating testing utilizes thermographic phosphor imaging and a unique optical method that obtains global, quantified heating data
- Flow visualization techniques include Schlieren, oil flow, and Planar Laser-Induced Fluorescence (PLIF)

Facility Applications

- The laboratory was a major contributor to the Shuttle Columbia Accident Investigation and the space shuttle Return-to-Flight program
- With renewed interest in planetary and space exploration, the AL has also contributed to the development of the Mars microprobe, Stardust sample-return capsule, Genesis solar probe, Orion crewed spacecraft, and the Ares launch system

Data Acquisition and Processing

Inputs	Analog and digital
Dynamic data acquisition	No
Customer computers	Yes
Classified capability	Yes

Characteristics

Facility	31-in. Mach 10 Air	20-in. Mach 6 Air	20-in. Mach 6 CF4	15-in. Mach 6 Air
Test gas	Dry air	Dry air	Tetrafluoromethane	Dry air
Stagnation pressure	150 to 1450 psi *(1.034E6 to 9.997E6 N/m^2)*	30 to 475 psi *(2.068E5 to 3.275 E6 N/m^2)*	100 to 2000 psi *(6.895E5 to 1.379E7 N/m^2)*	50 to 450 psi *(3.447E5 to 3.103E6 N/m^2)*
Stagnation temperature	1850 °R *(1028 °K)*	760 to 940 °R *(422 to 522 °K)*	1100 to 1480 °R *(611 to 822 °K)*	940 to 1260 °R *(522 to 700 °K)*
Speed	Mach 10	Mach 6	Mach 6 (13 to 18 simulation)	Mach 6
Reynolds number	0.2 to 2.2×10^6 per ft	0.5 to 8.0×10^6 per ft	0.05 to 0.75×10^6 per ft	0.5 to 6.0×10^6 per ft
Dynamic pressure	0.65 to 2.4 psi *(4.48E3 to 1.66E4 N/m^2)*	0.51 to 7.6 psi *(3.52E3 to 5.24E4 N/m^2)*	0.09 to 1.6 psi *(6.21E2 to 1.10E4 N/m^2)*	0.8 to 6.8 psi *(5.52E3 to 4.69E4 N/m^2)*
Shock density ratio	6.0	5.3	11.8	5.3
Test core size	14 by 14 in. *(0.36 by 0.36 m)*	12 by 12 in. *(0.30 by 0.30 m)*	14 in. diam *(0.36 m diam)*	10 in. diam *(0.25 m diam)*
Maximum run time	120 s	900 s	30 s	120 s

Instrumentation

Strain gauge balances	Six-component
Available corrections	Interactions, temperature effects, attitude tares, and axes orientation
Electronically scanned pressure (ESP) system	512 channels
Flow visualization	Schlieren photography, oil flow, fluorescent paint flow, and planar laser-induced fluorescence (PLIF)
IR thermography and two-color phosphor thermography	

Contact Information

http://www.aeronautics.nasa.gov/atp/index.html
Hubert Senter
NASA Langley Research Center
Phone: 757-864-5249
E-mail: Hubert.H.Senter@nasa.gov

NP-2008-11-121-LaRC